[0017] FIG. **5** shows the mutual dispersion of miscible fluids in a vesicle formation zone of the parallel flow device for the formation of vesicles of the present disclosure;

[0018] FIG. **6** shows the dispersion of a material at specific cross-sections of a vesicle formation zone of the parallel flow device for the formation of vesicles of the present disclosure;

[0019] FIG. **7** graphically shows the size and polydispersity of liposomes formed with the device and method of the present disclosure as compared to other devices and methods;

[0020] FIG. **8** graphically shows liposome size and polydispersity with respect to selected diameters of a feed line inlet feeding an organic material to the vesicle formation zone of the parallel flow device for the formation of vesicles of the present disclosure;

[0021] FIG. **9** graphically shows liposome size with respect to a center organic/lipid containing line inserted at varying distances beyond the termination of a multi-line assembly containing an aqueous phase, in the parallel flow device of FIG. **1**; and

[0022] FIG. **10** graphically shows liposome size with respect to varying flow rate ratios of an organic stream with an aqueous stream.

DETAILED DESCRIPTION

[0023] Disclosed herein is a parallel flow device configured to create an outer aqueous flowing stream sheathing or surrounding an organic stream containing amphiphilic molecules for the formation of vesicles and a method for the formation of vesicles. An aspect of the device comprises an outer longitudinally extending sheath configured for the flow through of an outer stream of an aqueous fluid that sheaths an inner organic stream flowing parallel with the aqueous stream. A central feed line is configured and disposed for the parallel flow of the organic stream into a central portion of the aqueous stream. The organic stream may contain a mixture of amphiphilic molecules, such as phospholipids. The outer sheathing may create physicochemical conditions in the aggregate co-flowing streams that are substantially symmetric about a cross-section of the co-flowing streams. As the mutually miscible aqueous and organic streams disperse or diffusively mix, the amphiphilic molecules may self-assemble into liposomal vesicles. Adjustment of the flow rates and the device dimensions may provide for control of the resultant vesicle size and/or size distribution.

[0024] An aspect of the vesicle formation device comprises a series of plastic, glass, and/or metal lines configured and disposed to establish an outer aqueous stream that substantially sheaths a parallel flowing inner organic stream. The device may comprise a fluid introduction zone and a vesicle formation zone.

[0025] The presently disclosed device may provide for a simple, facile method of vesicle preparation at the point of application, and may reduce or obviate the need for time-consuming size homogenization processing steps. Thus, the presently disclosed device may enable wide adoption and implementation of novel, state-of-the-art therapeutic agents in hitherto unknown scales. Further, the presently disclosed device may allow for preparative-scale vesicle formation. Further, the presently disclosed device may produce vesicles with polydispersities lower than the polydispersities of currently used devices.

[0026] FIG. **1** shows parallel flow device **100** configured for the formation of vesicles and

[0027] FIG. **2** shows an exploded view of a section of parallel flow device **100**. Device **100** has a fluid introduction zone **14** and a vesicle formation zone **16**. Fluid introduction zone **14** has a longitudinally extending sheath **12** disposed about ends of a plurality of outer feed lines **24**. Outer feed lines **24** may be secured in end portions of sections of outer sheath **12** with an adhesive, sealer, or other material **26** proximate ends thereof. Outer feed lines **24** may each have terminal end or outlet **27** in a common plane. Material **26** is optional and may not be required as sheath **12** may extend from sheath inlet **10** to sheath outlet **18**, about the plurality of outer feed lines **24**. In at least one aspect, material **26** is a sealer and is configured and disposed to restrict the flow of liquids through the plurality of outer feed lines **24** to outlets **27**. Central feed line **20** is disposed in a center of outer feed lines **24** and may extend beyond the terminal ends, or outlets **27**, of the plurality of outer feed lines **24**.

[0028] Sheath **12** has an inlet **10** configured and disposed for receiving an aqueous fluid flow. Central feed line **20** has an inlet **11** configured and disposed for receiving an organic fluid flow. Central feed line outlet **22** is downstream or at a greater distance from sheath inlet **10** than a plane common with the outlets **27** of the plurality of outer feed lines **24**.

[0029] Vesicle formation zone **16** comprises a length of outer sheath **12** and extends from central feed line outlet **22** to sheath outlet **18**. In the aspect shown in FIGS. **1** and **2**, device **100** has an outer annular longitudinally extending sheath **12** and central feed line **20** configured and disposed for feeding an intra-annular organic stream into a parallel flowing annular sheathing aqueous stream being fed into sheath **12**. However, it is to be understood that sheath **12** and/or central feed line **20** may have other than annular or round configurations. For example, sheath **12** and/or central feed line **20** may be rectangular, square, triangular, or have other geometric configurations.

[0030] Fluid introduction zone **16** may comprise a plurality of outer feed lines **24** disposed adjacent an inner surface of outer longitudinally extending sheath **12**, each of the plurality of outer feed lines **24** may have a terminating end, with an outlet **27**, in a plane substantially perpendicular to outer longitudinally extending sheath **12** and each outer feed line **24** may be configured for a flow through of an aqueous stream. A first outlet of fluid introduction zone **14** may comprise the terminating ends of the plurality of outer feed lines **27**. A second outlet of fluid introduction zone **14** may comprise outlet **22** of central feed line **20**. The first outlet may be upstream from the second outlet.

[0031] Device **100** may comprise sheath **12** in the form of a relatively large diameter poly(vinyl chloride) (PVC) line and central feed line **20** may be in the form of a relatively small diameter poly(ether ether ketone) (PEEK) tube. The PEEK tubing may be laterally inserted into the center of the PVC tubing substantially distal to the vesicle formation zone **16**. Using a pump, an organic stream may be introduced into the PEEK tubing at central feed line inlet **11**, and with a second pump, an aqueous stream may be introduced into the larger PVC line at sheath inlet **10**.

[0032] In at least one aspect, fluid introduction zone **14** and vesicle formation zone **16** are separate component parts of device **100**. For example, vesicle formation zone **16** may be mated with the fluid introduction zone **14**. In this aspect, the inner diameter of the PVC tubing, or sheath **12**, in fluid introduction zone **14** may be slightly larger than the outer perimeter of the plurality of outer feed lines **24**. Thus, fluid